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Forest Health Protection

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Special Project Report

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To: District Ranger, Almanor Ranger District, Lassen National Forest

Subject: Red turpentine beetle infestation following underburning in pine stands. (NE-SPR-05-05)

Summary

The Almanor Ranger District, Lassen National Forest, implemented an underburn in a ponderosa pine plantation between late April and early June 2004. The underburn followed a 2003 thinning project. There were a few areas within the underburn where a surface fire-to-crown fire transition occurred resulting in pockets of crown-scorched trees. In addition to crown injury, varying levels of cambial kill were also common on the lower boles of several trees. Following the underburn, several fire-injured trees were heavily attacked by the red turpentine beetle (RTB), *Dendroctonus valens*.

Concern by District personnel regarding the combination of fire injury and red turpentine beetle attacks resulted in a field visit by Forest Health Protection (FHP) on July 19, 2004. Besides trees killed outright by the fire, FHP personnel concluded that some additional trees were likely to die from their fire injuries, but tree mortality resulting from the RTB attacks would be minimal and the spread of RTB to unburned trees unlikely. Mike Derrig, Acting District Ranger, decided to take no action regarding tree removal and FHP agreed to establish a study to monitor tree survival in relation to RTB attacks and fire injuries. This report provides biological information on the red turpentine beetle, a historical review of RTB activity in California, results from a previous RTB monitoring effort and a summary of the initial data collected for the Prattville tree survival study. FHP will provide additional annual reports to inform District personnel of the results of tree monitoring.

Questions related to this report may be directed to Sheri Smith or Danny Cluck.

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Description and Life History

The red turpentine beetle is a common species of bark beetle that attacks all native pine species in California and most pine species throughout North America. The external sign of attack is a large pitch tube (s), typically located around the lower basal portion of the tree (Fig 1). Occasionally attacks may be present up to about 15 feet or higher on the bole. The pitch tubes are about 1-2 inches in diameter and are typically pink to reddish brown with boring dust and frass embedded in the resin. Attacks on stressed trees may result in clumps of coarse, granular reddish pitch around the base of trees instead of the more typical pitch tubes. Beetles are reddish brown and average about five sixteenths of an inch long (Fig. 1), the largest beetle in the genus *Dendroctonus*. Locally, adult beetles fly from late March throughout the fall, with peak flight occurring in late May through early June. Similar to other bark beetles, the red turpentine beetle is associated with blue staining fungi.

The galleries are the internal evidence of attack and are generally vertical, partially packed with boring dust and frass, and are about an inch or so in width (Fig 3). They vary in length from a few inches to over a foot and may extend down into the roots several feet from the bole. Larvae hatch from eggs laid along the sides of the gallery and feed as a group in the inner bark, which results in the death of that patch of inner bark. Larval feeding continues for about 8 weeks followed by transformation of larvae into pupae. Individual cells (pupal chambers) are constructed between the bark and wood for pupation. New adults emerge from the pupal chambers in about two weeks and may move about within the gallery for a few days to several months. RTB overwinters in the larval and adult stage and depending upon temperature, which determines development rate, there may be more than one generation per year.

Figure 1. Red turpentine beetle pitch tubes.

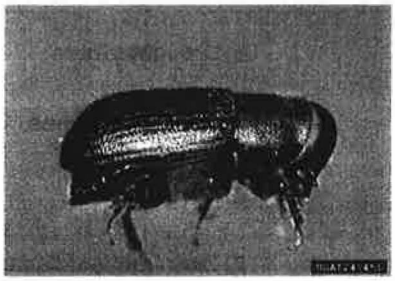


Figure 2. Adult red turpentine beetle.

Figure 3. Red turpentine beetle gallery.

Attack habits

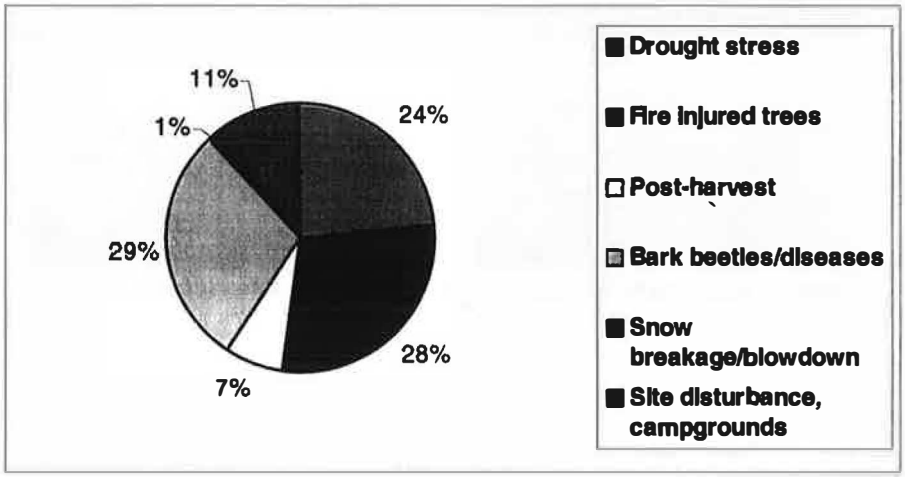
The RTB usually attacks injured, weakened or dying trees and freshly cut stumps. It is commonly found in stands following harvest operations, particularly attacking residual stumps, and also readily attacks fire injured trees, supporting the conclusion that the beetles are attracted to the odor of tree pitch or resin. RTB is rarely regarded as a primary tree-killing beetle, but may influence tree survival in some situations. Repeated attacks may kill trees, but more often, attacked trees are rendered more susceptible to attack by primary bark beetles.

Noted occurrences of RTB

The red turpentine beetle is commonly mentioned in various published and unpublished literature from the past one hundred years. Mention of the RTB dates back to as early as 1909, where Hopkins (1909) reported its preference for attacking injured or dying trees, stumps, fire scorched trees and trees killed by other bark beetles. Struble (1927), from work conducted on the Sierra National Forest, concluded that RTB is a secondary insect and is rarely able to make successful attacks until another agent has overcome the tree. He found that RTB typically had the youngest broods in study trees, indicating they were the latest to attack. In the early 1940's, Bongberg (1941) and Johnson (1942) mention RTB attacking freshly cut stumps at Blacks Mountain Experimental Forest. Both reported some attacks on green trees but Johnson found these attacks were limited to trees injured by logging or those that were in close proximity to stumps or green logs.

The longest consistent account of forest insect and disease conditions in California can be found in "Forest Pest Conditions in California," a publication which dates back to the early 1960's and continues to be produced annually. A review of the content of these annual reports for information regarding RTB in California is contained in Table 1. RTB was mentioned numerous times in these reports between 1960 and 2004. It was most commonly reported in association with other bark beetles, diseases, and dwarf mistletoe infection (Fig 4). Reports of attacks during drought periods and following wild or prescribed fires were also frequent.

Figure 4. Percent of RTB occurrences in Forest Pest Conditions reports between 1960 - 2004 by associated agent or management activity.



Throughout these reports actual tree mortality caused by this bark beetle is rarely mentioned over the forty-four year period (1960-2004), and when it is mentioned, it is always associated with some recent management activity, drought or in association with other bark beetles. During drought periods in 1960 and 2001-2004, pines infested with RTB were reported to have died in conjunction with other bark beetles. In 1963 and 2001, some RTB-related tree mortality was noted following thinning or chipping. In 1990, mortality of planted Monterey pines was noted in Mendocino County, and between 2000 and 2003 mortality of pole size trees occurred in a plantation in the northeastern part of the state that had recently been thinned, followed by soil tilling/ripping. These associations of RTB activity with other agents are consistent with the findings by Owen (1985) where he reported that RTB pitch tubes are typically indicators of various diseases, injuries or dwarf mistletoe infection on pines. There are no reports of an RTB infestation in a specific area (underburn, thinned area, etc.) that subsequently extended into healthy trees. In vigorous trees, the likelihood of successful reproduction is extremely low. The flow of resin usually drowns out the adult beetles and they fail to develop successful broods.

Over the past 15 years or so, there has been a notable increase in the reports of RTB attacks on fire-injured trees. This trend is likely to continue to increase proportionally as the acres of underburning, in stands with a pine component, increases.

Specific studies related to RTB attacked trees

Twin Thinning/Salvage – Hat Creek Ranger District (1996-1999)

Following a thinning/salvage project in a mixed stand of ponderosa and Jeffrey pine near Old Station, CA, several stumps and residual trees were attacked by RTB. Size of the attacked trees ranged from about 5" to 30" DBH. District personnel were concerned over the possibility of mortality in the residual stands due to the RTB attacks and requested a field evaluation by Forest Health Protection personnel. Based on the knowledge that RTB rarely kills otherwise healthy trees, FHP personnel initially recommended no action beyond tree monitoring. It was agreed that FHP would monitor several trees over a three-year period and advise the District if an alternate action were recommended.

During May 1996 FHP collected data on fifty trees (*). The objective of the study was to monitor RTB attacked trees to determine if there was a relationship between the number of RTB attacks, tree DBH and subsequent tree mortality. Data collected included DBH, number of RTB attacks and height of the highest (ft) attack on the bole (Table 2). Most (66%) of the attacks on the study trees were concentrated on the lower 6' of the bole. The remaining attacks all occurred between 6 and 15 feet, with the exception of one attack at 40 feet. Additional new RTB attacks were observed in subsequent years and were added to the total number of attacks per tree.

Table 2. Number of trees by DBH class and total number of red turpentine beetle attacks.

DBH	Number of trees	RTB attacks <25	RTB attacks 25-50	RTB attacks 51-75	RTB attacks 76-100	RTB attacks > 100
> 6 – 10"	4	4	0	0	0	0
> 10 – 15"	21	14	7	0	0	0
> 15 – 20"	13	3	4	4	2	0
> 20 – 30"	9	1	2	0	3	3

* Three trees were cut prior to the end of the monitoring period and were dropped from the study.

Little mortality of the RTB attacked trees was observed during the study period. Two trees died within the first year followed by no mortality through 1999. We concluded that without the support of primary bark beetles or some other stress agent, RTB was, generally incapable of causing tree mortality in the thinned trees. As expected, larger diameter trees with more bark surface had more attacks than smaller trees. The larger diameter trees (>20-30"DBH) had an average of 81 attacks per tree, trees with diameters >15-20" DBH had an average of 43 attacks per tree, followed by averages of 20 and 9 attacks for two remaining size classes, respectively.

Prattville Underburn – Almanor Ranger District (2004 – ongoing)

This monitoring effort was initiated following an underburn conducted between late April and early June 2004 in a ponderosa pine plantation. Following the underburn, several fire-injured trees were heavily attacked by RTB. Data were collected during August 2004 and trees were monitored for changes in condition in early November 2004. One hundred ninety three trees were included in the study; all were ponderosa pine except for one sugar pine. In addition to collecting typical tree data and number of RTB attacks/tree (Table 3), crown and cambium injuries resulting from the fire were also characterized. An attempt was made during tree selection to maximize the number of RTB attacks/tree while minimizing fire injuries to facilitate a more accurate determination of the cause of tree death (i.e. trees that received fatal fire injuries will die regardless of RTB attacks). An estimate of the percent remaining live crown volume was obtained to describe crown injury (Table 4) and a cambium damage rating (Table 5) was obtained by drilling into the cambium in each quadrant with a 1" hole saw bit. Cambium was determined to be live or dead for each quadrant and then each tree was given a rating between 0-4 (total number of dead samples). The number of RTB attacks was recorded for each quadrant corresponding with a cambium sample to determine if there was a relationship between attack pattern and cambium condition.

Based on an initial review of these data some of the trees included in the study would be expected to die from their fire injuries alone. In comparing trees of similar diameters (10 – 20" DBH) and comparable levels of crown injury (minimal) from the 2002 Cone Fire, about 75% of the trees with a cambium damage rating of four died within 2 years post-fire. There are a total of 30 trees in the Prattville study with a cambium damage rating of 4.

In comparing the number of RTB attacks by quadrant with the condition (live or dead) of the equivalent cambium sample, it is interesting to note that quadrants where the cambium sample was dead, had on average, twice as many RTB attacks that those where the sample was alive. Fire-killed cambium would perhaps be unsuitable for feeding or breeding, so beetle survival and

brood production may be low in these areas. Additional work may be conducted this spring to assess brood production in some of the fire-injured trees in the Prattville underburn.

Table 3. Number of trees by DBH class and total number of red turpentine beetle attacks.

DBH	Number of trees	RTB attacks <10	RTB attacks 10-25	RTB attacks 26-50	RTB attacks 50-110
> 9 – 15"	127	55	54	13	5
> 15 – 20"	66	17	23	16	10

Table 4. Number of trees by DBH class and percent remaining live crown volume.

Live Crown Volume (%)	DBH > 9 – 15"	DBH > 15 – 20"
25<35	4	0
>=35	123	66

Table 5. Number of trees by DBH class and cambium damage rating.

Cambium damage rating	DBH > 9 – 15"	DBH > 15 – 20"
0	36	26
1	37	19
2	21	9
3	9	6
4	18	12

The Prattville underburn RTB attacked/fire injured trees were monitored for changes in condition on November 2, 2004. At that time twenty-three trees had completely dead crowns (the criteria used to indicate tree death for the purposes of this study). Of the 23 dead trees, 17 had cambium damage ratings of 4, which equates to each of 4 samples taken being dead. In addition, fourteen of the dead trees had been attacked by western pine beetle (WPB), *Dendroctonus brevicomis*, a common associate of the RTB, and one tree had been attacked by pine engraver beetles, *Ips* sp. The number of RTB attacks per dead tree ranged from 2 to 79. FHP would like to assess the success of both western pine beetle and RTB brood production and requests that these dead trees remain on the site undisturbed until late summer 2005. Additional tagging/flagging may be required to deter tree cutting for firewood. FHP will continue to monitor the remaining trees in the study twice annually to assess changes in tree condition.

It is premature to draw any conclusions regarding the affect of the RTB attacks on the fire-injured trees. Based on earlier discussions in this report regarding the typical inability of RTB to successfully attack healthy trees, FHP still maintains that the likelihood of the RTB attacks spreading beyond the boundary of the underburn is highly unlikely. If District or FHP personnel make observations to the contrary, appropriate contacts will be made to discuss management alternatives.

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Figure 1. Ladd Livingston, Idaho Department of Lands
Figure 2. Bob Oakes, USDA Forest Service
Figure 3. Kenneth E. Gibson, USDA Forest Service

Table 1. Reports of red turpentine beetle occurrences in Forest Pest Conditions in California between 1960-2004.

Year	Comments	Location	Host
1960	Unusually aggressive in some stands, killing otherwise uninfested trees, extended drought period		Pines
1962	Aggressive outbreak in fire-weakened trees	Los Angeles Co.	Pines
1962	Frequent infestations but tree killing restricted to a few infestations in thinned stands of young trees.	Siskiyou, Modoc & Lassen Counties	Ponderosa pine and Jeffrey pine
1962	Sugar pines infected with WPBR attacked.	Siskiyou Co.	Sugar pine
1963	Attacks caused moderate to heavy damage in thinned areas	Mendocino, Modoc, & Lassen Counties	Ponderosa pine and Jeffrey pine
1963	Heavy buildup in pine blowdown	Lassen, Modoc, Shasta, Siskiyou & Trinity Counties	Pines
1963	Fire damaged trees	Santa Barbara & San Diego Counties	Ponderosa pine
1965	Campground	Shasta County	Knobcone pine
1967	Commonly associated with attacks by other bark beetles.		Pines
1970	Causing concern	Siskiyou, Trinity, Placer & Madera Counties	Ponderosa pine
1971	In conjunction with a western pine beetle epidemic	McCloud Flats	Ponderosa pine
1977	In conjunction with pine engravers, off site planted trees.	Contra Costa County	Monterey pine
1978	On occasion contributed to the death of drought stressed trees.		Sugar pines
1979	Vigorous RTB activity	Mariposa, &Madera Counties	Ponderosa
1980	RTB attacks unusually common, infested trees not killed	Mariposa County	Ponderosa
1980	With western pine beetle	Lassen & Siskiyou Counties	
1982	Drought-stressed pines, low impact	San Bernardino, Riverside & San Diego Counties	
1983	Under burned stands, little mortality occurred	Plumas County	
1987	Pines under stress in campgrounds and developed sites	Mariposa County	
1987	Site disturbance	Mendocino County	
1987	In conjunction with pine engravers and pitch canker disease	Santa Cruz County	Monterey pines
1988	Scattered old growth, drought stress	Mendocino & Lake Counties	Ponderosa and sugar pines

Table 1. continued

Year	Comments	Location	Host
1988	Drought stressed trees in conjunction with mountain and western pine beetle	Southern and central Sierra Nevada	Ponderosa and sugar pines
1988	In conjunction with pine engravers and pitch canker disease, site disturbance	Santa Cruz, Santa Clara, Alameda, Lake, Napa, Monterey, Sonoma, Marin & Solano Counties	Monterey pines
1989	Drought stress	Fresno, Amador & El Dorado Counties	Ponderosa and sugar pine
1989	In conjunction with pine engravers and pitch canker disease, site disturbance	Santa Cruz, Santa Clara, Alameda & Napa Counties	Monterey pines
1989	Scorched trees from 1987 fire, mortality very light	Mendocino, Lake & Colusa County	
1989	In conjunction with western pine beetle	Santa Barbara County	Ponderosa and Coulter pines
1990	In conjunction with pitch canker disease	Santa Cruz County	Monterey pines
1990	Prolonged drought, harsh sites overstocking, dwarf mistletoe infestation	northwestern California	Ponderosa and sugar pincs
1990	Black stain root disease	Siskiyou County	Ponderosa pine
1990	Mortality of planted 20 year old trees	Mendocino Cunty	Monterey pine
1991	In conjunction with pitch canker disease, drought stress	Santa Cruz & Alameda Counties	Monterey pines
1991	With other bark beetles, drought stress	Northern California	
1991	Severe drought stress	Westside Sierra Nevada	Ponderosa and sugar pines
1992	In conjunction with pitch canker disease, drought stress	Santa Cruz & Alameda Counties	Monterey pines
1992	Drought stress with wood borers	Northern California	Ponderosa and Jeffrey pine
1992	With western pine beetle and mountain pine beetle, drought stress	Sierra Nevada	Ponderosa and sugar pine
1993	Declining trees	Mendocino County	Bishop pines
1993	Associated with mountain, western and Jeffrey pine beetles	Northern California	Ponderosa and Jeffrey pine
1993	Fire scorched trees	Sierra County	Ponderosa pines
1993	With Jeffrey pine beetles	Lake Tahoe	Jeffrey pines
1994	With pine engravers and western pine beetle	North coast	Ponderosa pine
1994	With pine engravers	Mendocino County	Monterey pines
1994	Associated with mountain, western and Jeffrey pine beetles, drought conditions	Siskiyou County	Ponderosa pines
1994	Large diameter trees scorched in1992 fire.	El Dorado County	Sugar pines
1994	Trees scorched in 1993 fire	Los Angeles County	Mostly Coulter pines
1995	Increased attacks	Lake, Mendocino	Ponderosa pines

Table 1. continued

Year	Comments	Location	Host
1995	Residual trees following harvest, no mortality	Tahoe National Forest	Lodgepole pines
1995	Snow breakage, attacked residual stobs	Tahoe National Forest	Ponderosa pines
1995	With Jeffrey pine beetle at low levels	Inyo NF and Lake Tahoe Basin	Jeffrey pines
1996	Hundreds of residual trees attacked following harvest	Lassen National Forest	Ponderosa and Jeffrey pines
1996	Trees scorched in prescribed or wildfires, very little tree mortality	Several locations throughout California	Ponderosa, Jeffrey and sugar pines
1996	Construction activities	Stanislaus NF	Ponderosa and sugar pines
1997	Trees scorched in prescribed fires and mechanically injured trees, little mortality	Shasta-Trinity NF, Tahoe NF, Plumas NF	Ponderosa pines
1997	Trees scorched in prescribed fires and following harvest, little mortality with the exception of one plantation that had severe fire injury	Inyo NF, Eldorado NF, Sierra NF, Stanislaus NF, Sequoia NF	Ponderosa and sugar pines
1997 - 2004	Third year of attacks in a campground, also western pine beetles and wood borers	Stanislaus NF	
1997	With annosus root disease and dwarf mistletoe	Cleveland NF	Jeffrey pines
1997	Fire scorched trees	San Bernardino Mountains	Jeffrey pines
1998	Trees scorched in a prescribed fire	Shasta-Trinity NF	Ponderosa pines
1998	Attacks following prescribed fires, wildfires and thinning projects, minimal, if any, mortality	Sierra Nevada, Southern California mountains and valleys	Jeffrey and ponderosa pines
1999	Attacks following prescribed and wildfires	Northeastern CA, Mt. Shasta, southern CA	Ponderosa pines, other pines
2000 - 2003	Mortality of pole size plantation trees following thinning and soil tilling/ripping, little evidence of successful brood production	Siskiyou County	Ponderosa pines
2000	Trees scorched in wildfires and prescribed fires	Northeastern CA	Ponderosa, sugar and Jeffrey pines
2000	Off site, low elevation plantation trees, with pine engravers	Angeles NF	Pines
2000	Trees scorched in a wildfire	Southern CA	Pines
2001	Annosus root disease centers and prescribe burned areas	Siskiyou County	Ponderosa pines
2001	Mortality of drought stresses saplings	Klamath NF	Ponderosa pines
2001	Mortality of saplings with fresh pine chips around the base.	Klamath NF	Ponderosa pines
2001	Trees scorched in wildfires and prescribed fires	Northeastern CA and Inyo NF, Sierra NF	Ponderosa, sugar and Jeffrey pines
2001	Group kills with pine engravers	Modoc NF, Lassen NF	Jeffrey and ponderosa pines

Table 1. continued

Year	Comments	Location	Host
2001	Trees scorched in wildfires and prescribed fires	Inyo NF,	Ponderosa and Jeffrey pines
2001	With Jeffrey pine beetle and pine engravers in a campground	Inyo NF	Jeffrey pines
2001	Attacked pines weakened by drought, annosus root disease and dwarf mistletoe	Southern CA	Ponderosa and Jeffrey pines
2001	Attacks observed	Southern CA	Single leaf pinyon
2002	Trees scorched in wildfires and prescribed fires	Modoc NF, Tahoe NF, Lassen NF, Eldorado NF, Sequoia NF, Stanislaus NF	Ponderosa, Jeffrey and sugar pines
2002 - 2004	Abundant on all pine species, drought stress	Southern CA	All pines
2003	With pine engravers	Shasta-Trinity NF	Knobcone pine
2003	Fire injured trees	Lassen NF	Ponderosa and Jeffrey pines
2004	With western pine beetle	Boggs Mtn. Dem. State Forest and also in Siskiyou, Modoc and Lassen Counties	Ponderosa pine
2004	Trees scorched in wildfires and prescribed fires	Lassen NF and southern Sierra Nevada	Ponderosa, Jeffrey and sugar pines